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Vaught et al.

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(54) **BALL LAUNCHING DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

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Related U.S. Application Data

(63) Continuation of application No. 14/565,870, filed on Dec. 10, 2014, now Pat. No. 9,067,119.

(60) Provisional application No. 61/915,779, filed on Dec. 13, 2013.

(51) **Int. Cl.**
F41B 3/00 (2006.01)
A63B 69/40 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A63B 69/408*** (2013.01); ***A63B 24/00*** (2013.01); ***A63B 69/385*** (2013.01); ***F41B 3/03*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. A63B 69/385; A63B 69/40; A63B 69/407; A63B 69/408; F41B 3/03
See application file for complete search history.

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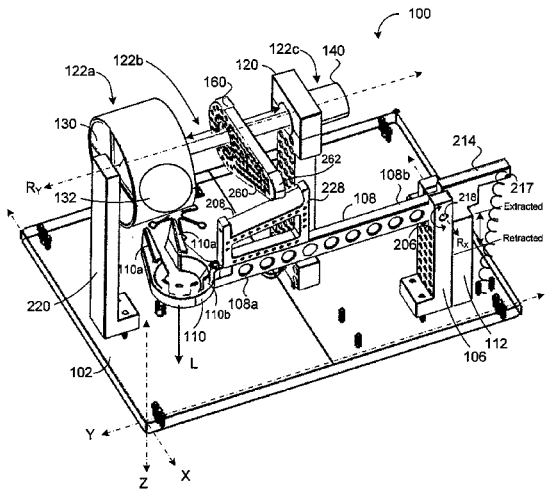
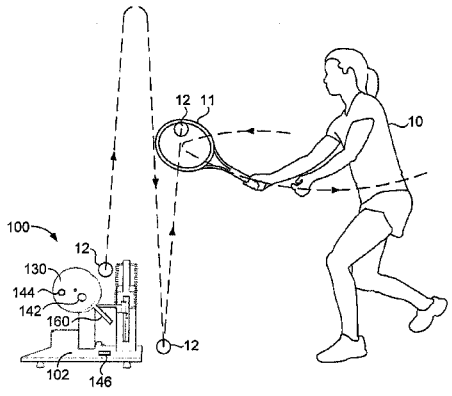
(57) **ABSTRACT**

A ball launcher includes a base and a thrower arm defining a ball cradle. An arm holder is disposed on the base and pivotally supports the thrower arm about a first axis of rotation, the thrower arm spring biased about the first axis of rotation. A rotating shaft defines a second axis of rotation substantially parallel to the fore-aft axis. A ball loader is coupled to the rotating shaft for common rotation about the second axis of rotation, the ball loader defining a ball receptacle. A loader arm is releasably connected to the rotating shaft for common rotation about the second axis of rotation. The loader arm defines a longitudinal axis substantially perpendicular to the second axis of rotation of the rotating shaft and has a length extending away from the rotating shaft.

24 Claims, 10 Drawing Sheets





(51) **Int. Cl.**

A63B 69/38	(2006.01)
F41B 3/03	(2006.01)
A63B 24/00	(2006.01)
F41B 3/04	(2006.01)
A63B 71/06	(2006.01)
A63B 47/00	(2006.01)
A63B 69/00	(2006.01)

(52) **U.S. Cl.**

CPC ***F41B 3/04*** (2013.01); *A63B 47/002* (2013.01); *A63B 69/38* (2013.01); *A63B 71/0622* (2013.01); *A63B 2069/0008* (2013.01); *A63B 2071/0625* (2013.01); *A63B 2207/02* (2013.01); *A63B 2208/0204* (2013.01); *A63B 2225/09* (2013.01); *A63B 2225/093* (2013.01); *A63B 2225/50* (2013.01); *A63B 2243/0083* (2013.01)

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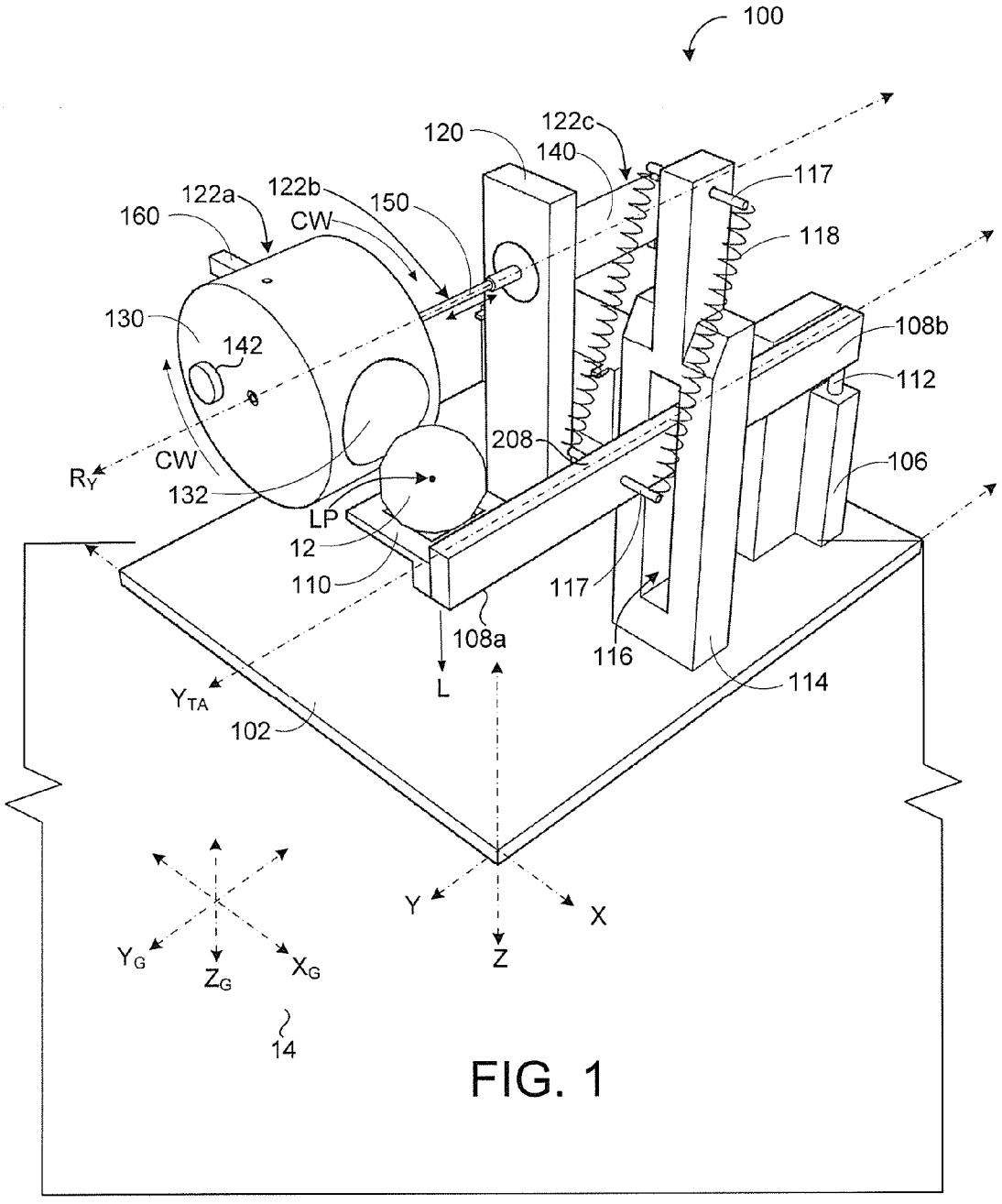
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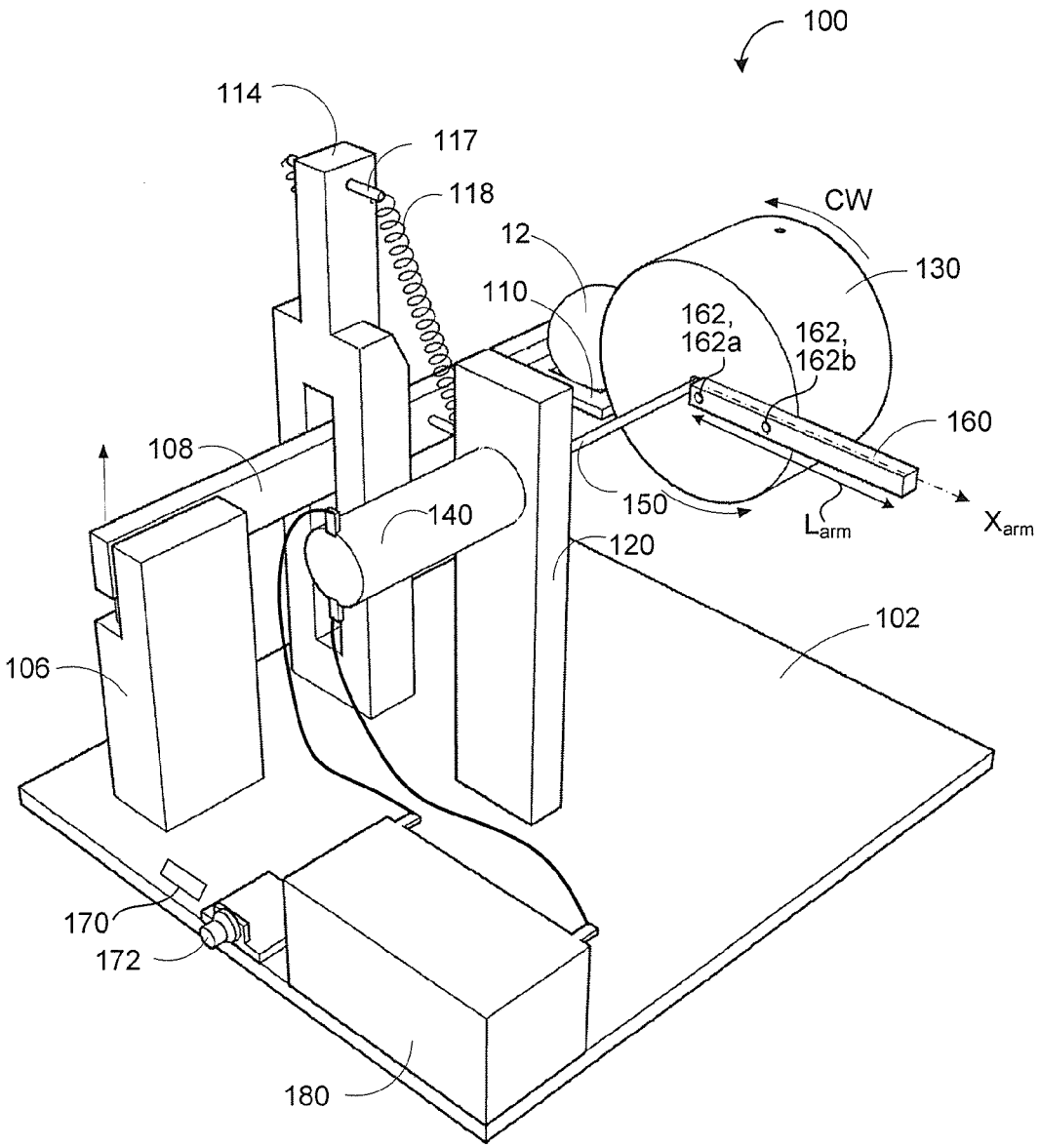
120
122c
140
117
122a
122b
150
160
CW
118
130
142
108b
112
208
106
R_Y
CW
132
LP
12
110
117
108a
116
114
L
Y_{TA}
102
Y
X
Z
Y_G
Z_G
X_G
14

FIG. 1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114
117
118
12
110
CW
130
162,
162a
162,
162b
160
108
140
150
120
L_{arm}
X_{arm}
102
106
170
172
180

FIG. 2

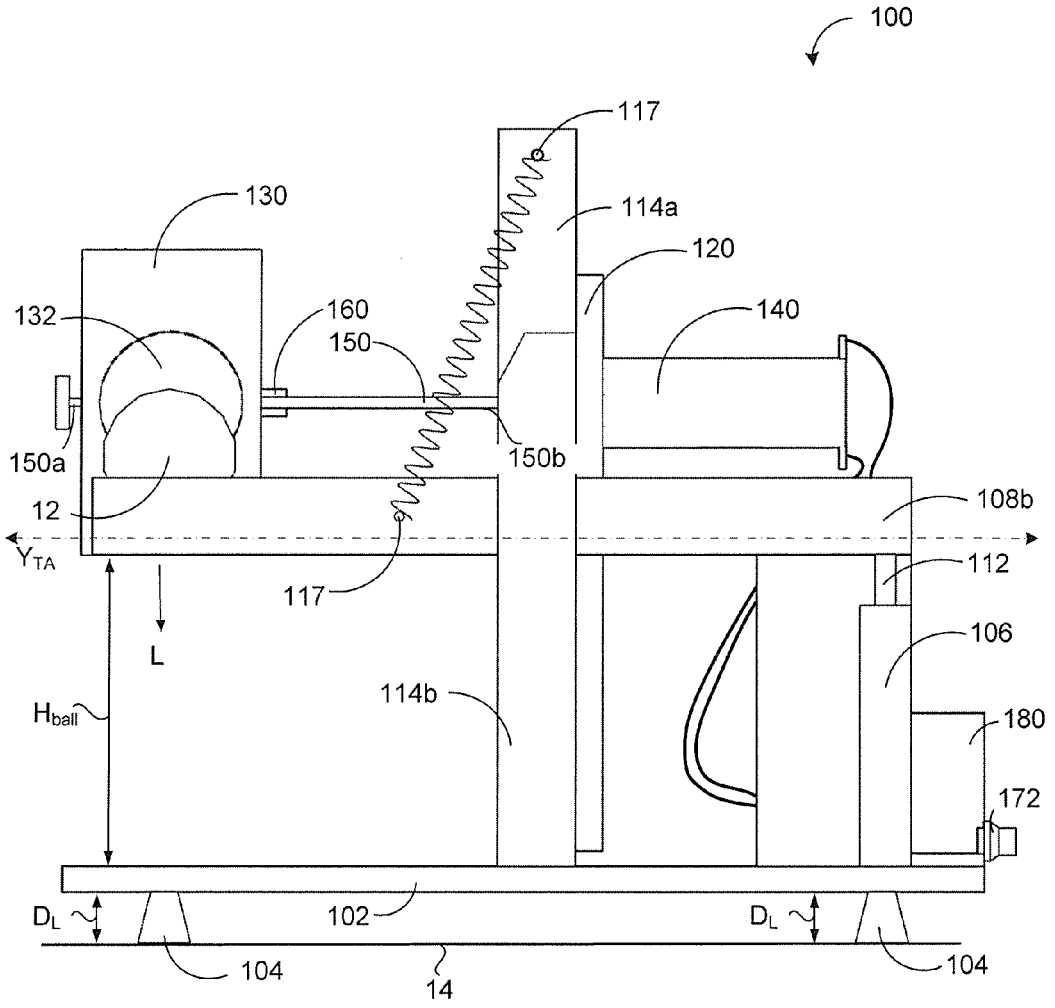

100
117
130
114a
120
132
160
150
140
150a
150b
12
108b
Y_{TA}
117
112
L
106
H_{ball}
114b
180
172
D_L
102
D_L
104
14
104

FIG. 3

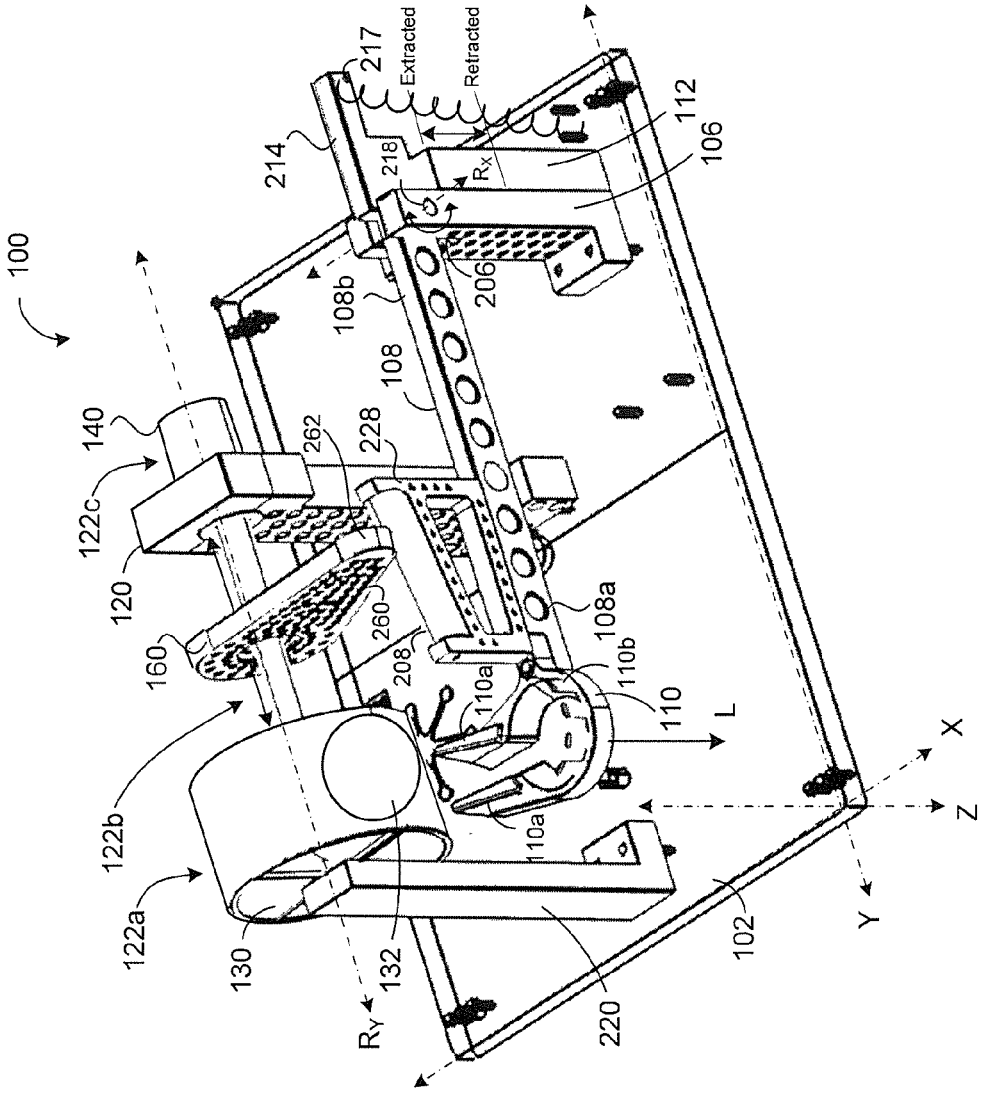
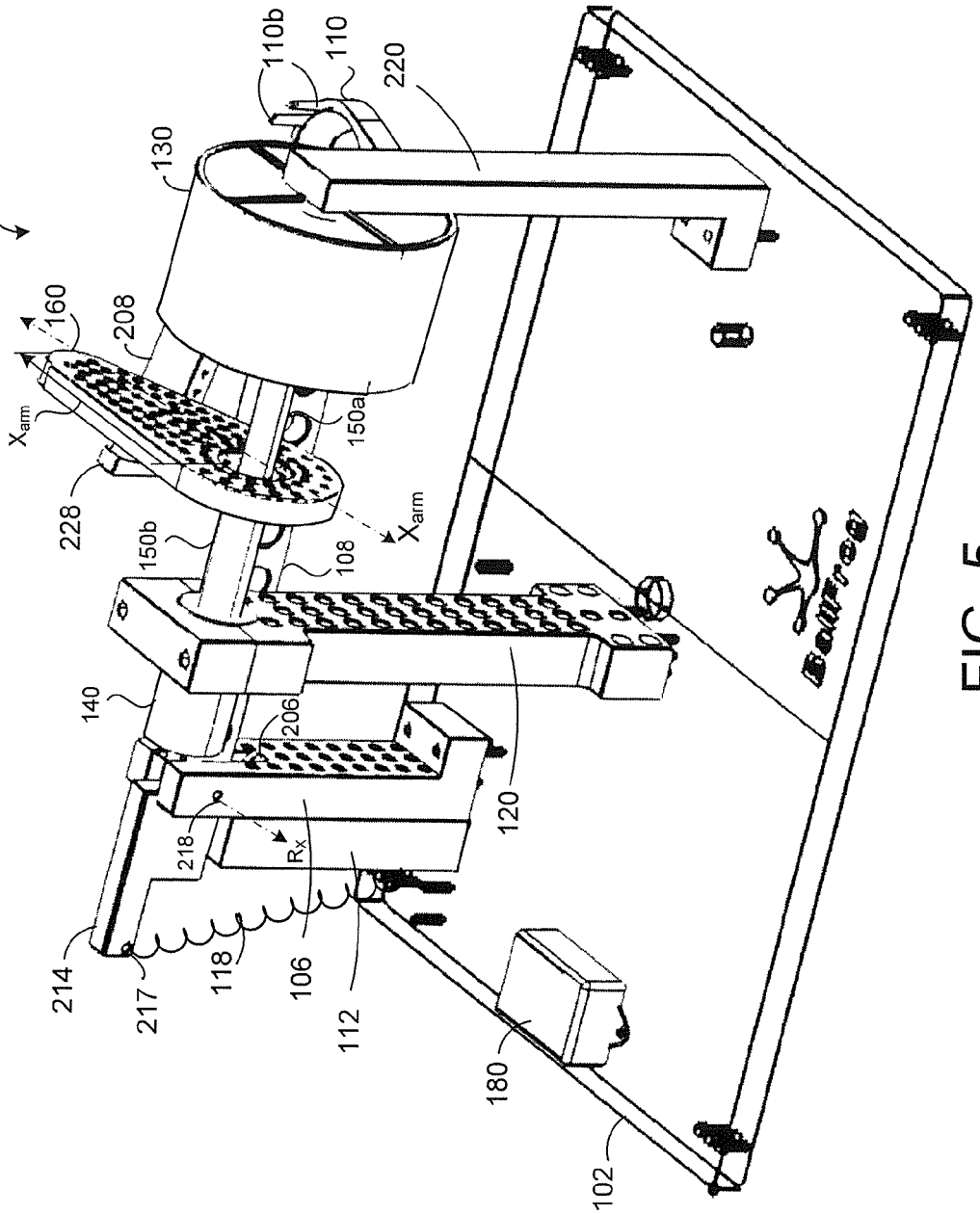

100
140
122c
120
160
122b
122a
130
132
R_Y
220
102
Y
X
Z
L
110
110a
110b
110a
208
260
108a
108
108b
262
228
206
214
218
217
Extracted
Retracted
R_X
112
106

FIG. 4


100
110b
110
220
130
160
208
X_{arm}
150a
228
150b
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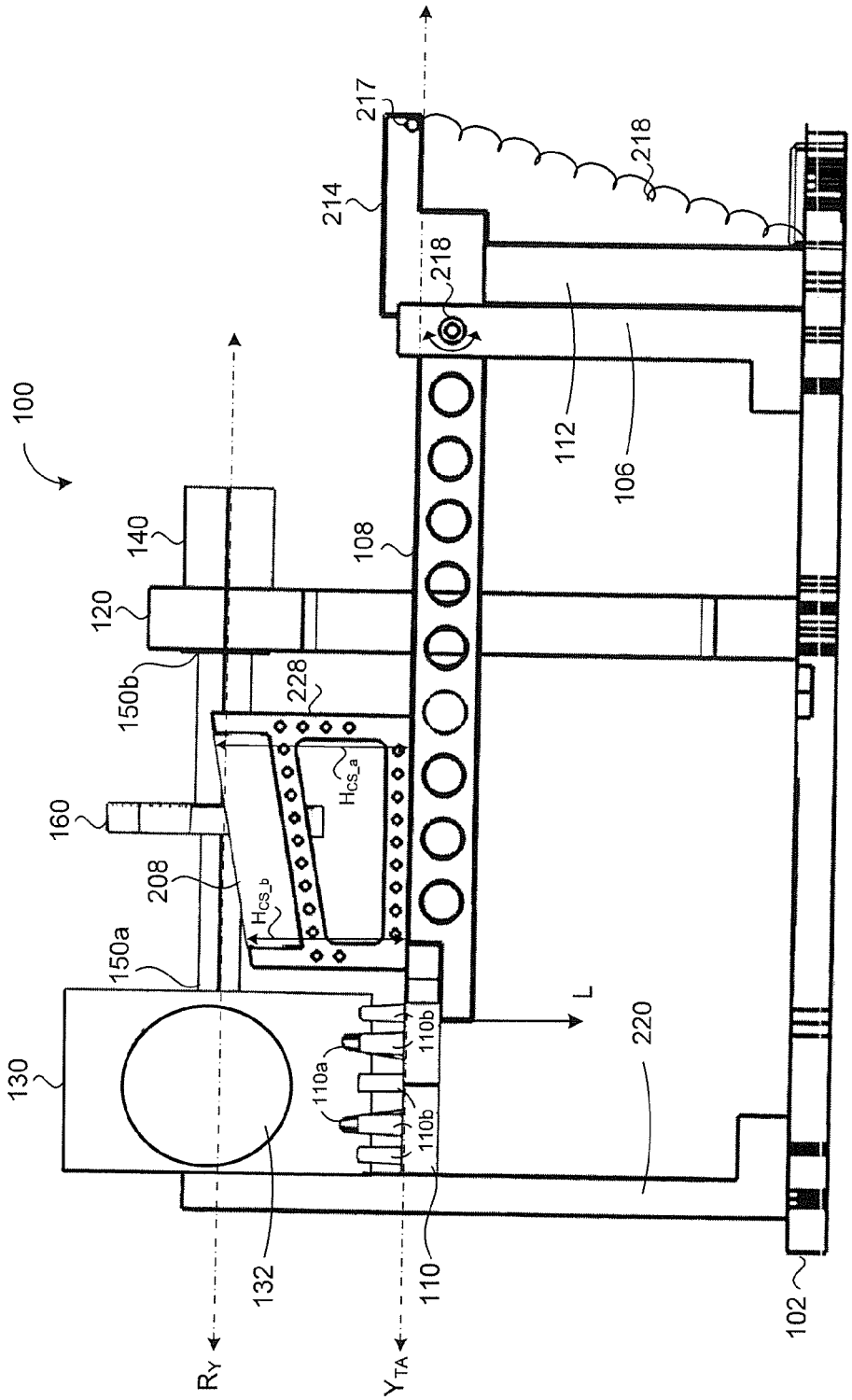
X_{arm}
140
206
120
218
R_X
214
217
118
106
112
180
102

FIG. 5


100
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110a
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120
130
132
140
150a
150b
160
208
214
217
218
220
228
L
H_{CS_a}
H_{CS_b}
R_Y
Y_{TA}

FIG. 6

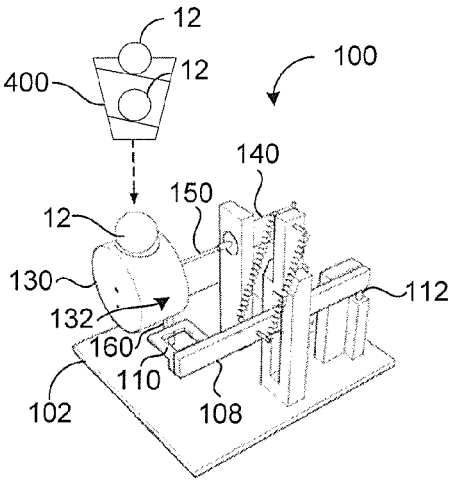

FIG. 7

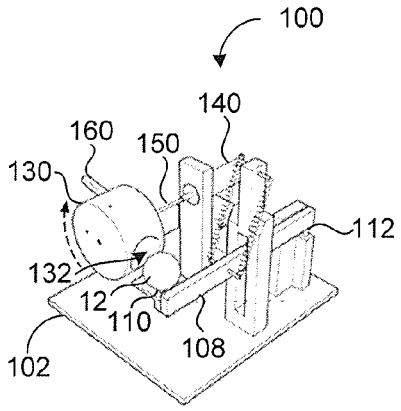

FIG. 8

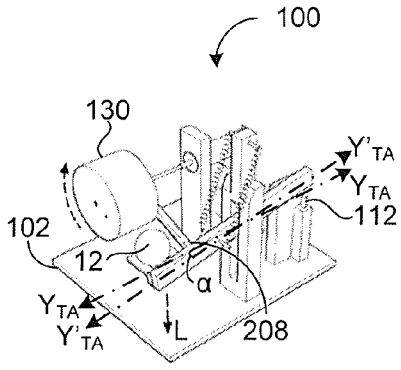

FIG. 9

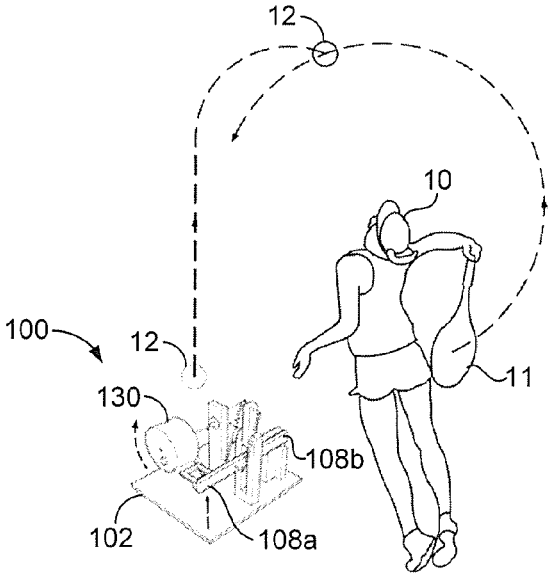

FIG. 10A

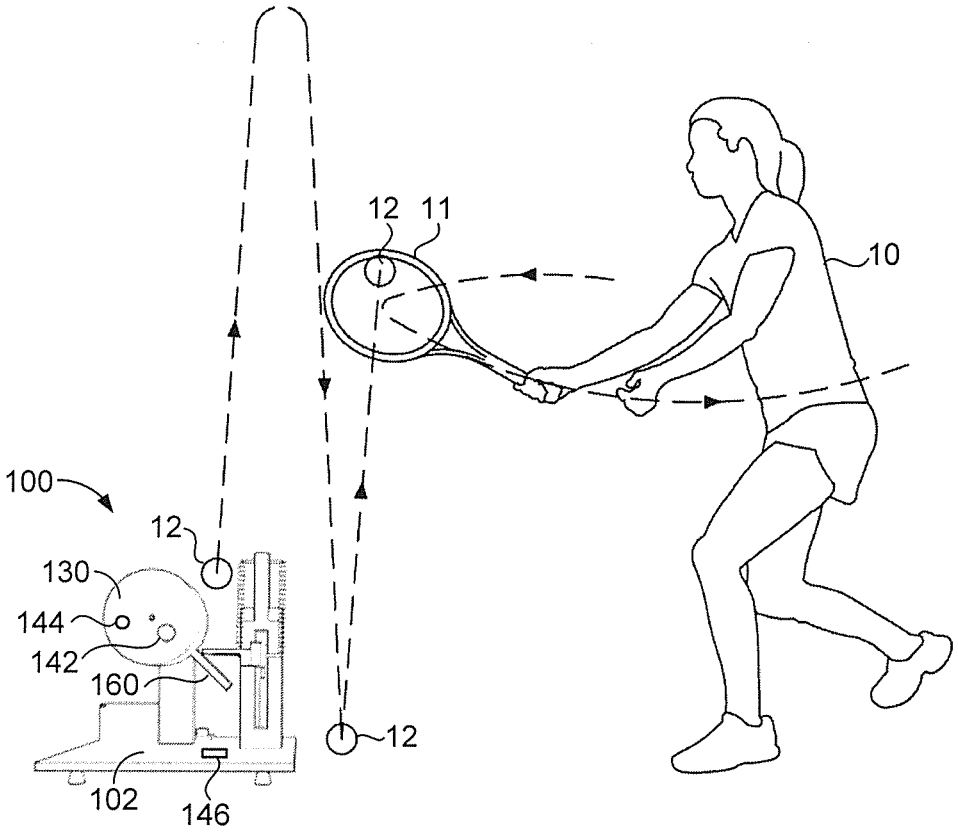

FIG. 10B

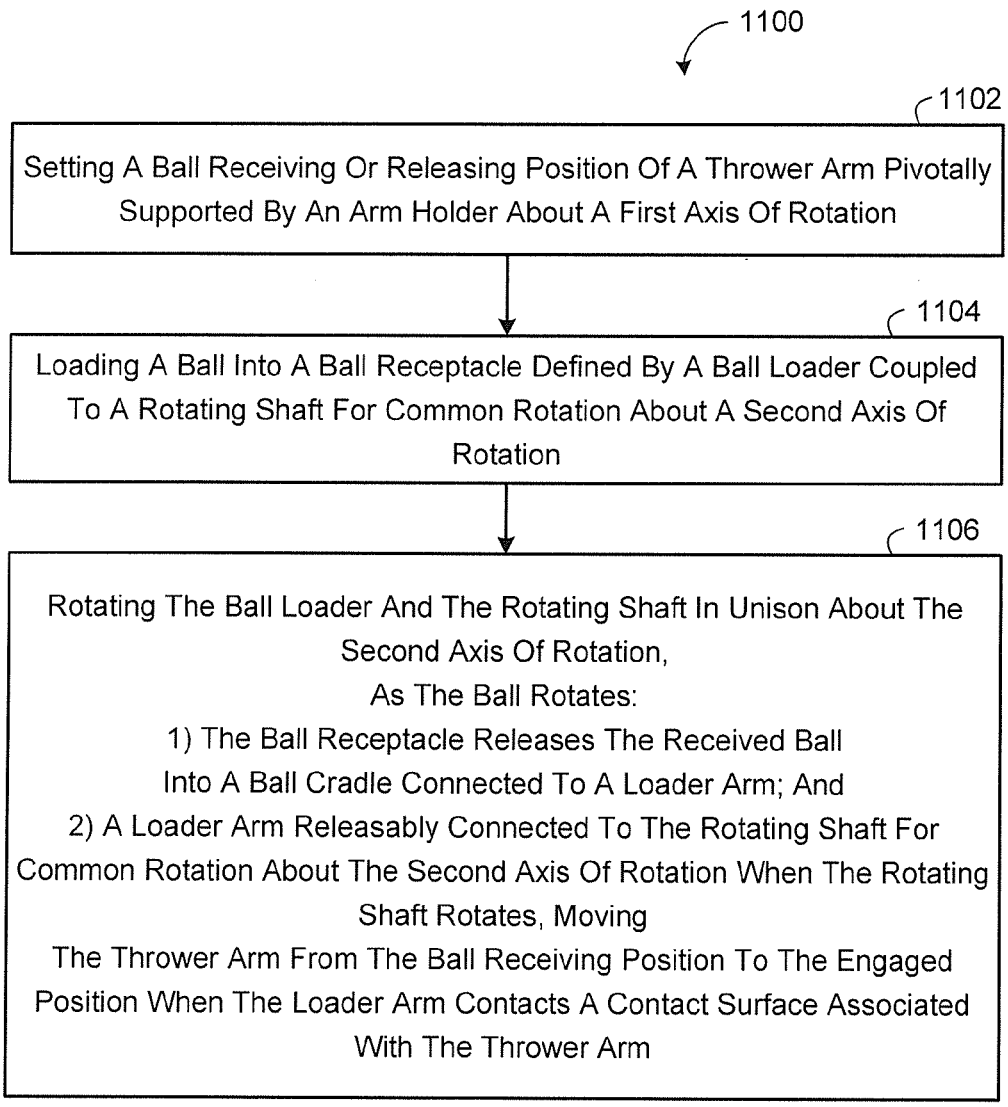
1100
1102
Setting A Ball Receiving Or Releasing Position Of A Thrower Arm Pivotally Supported By An Arm Holder About A First Axis Of Rotation
1104
Loading A Ball Into A Ball Receptacle Defined By A Ball Loader Coupled To A Rotating Shaft For Common Rotation About A Second Axis Of Rotation
1106
Rotating The Ball Loader And The Rotating Shaft In Unison About The Second Axis Of Rotation,
As The Ball Rotates:
1) The Ball Receptacle Releases The Received Ball Into A Ball Cradle Connected To A Loader Arm; And
2) A Loader Arm Releasably Connected To The Rotating Shaft For Common Rotation About The Second Axis Of Rotation When The Rotating Shaft Rotates, Moving
The Thrower Arm From The Ball Receiving Position To The Engaged Position When The Loader Arm Contacts A Contact Surface Associated With The Thrower Arm

FIG. 11

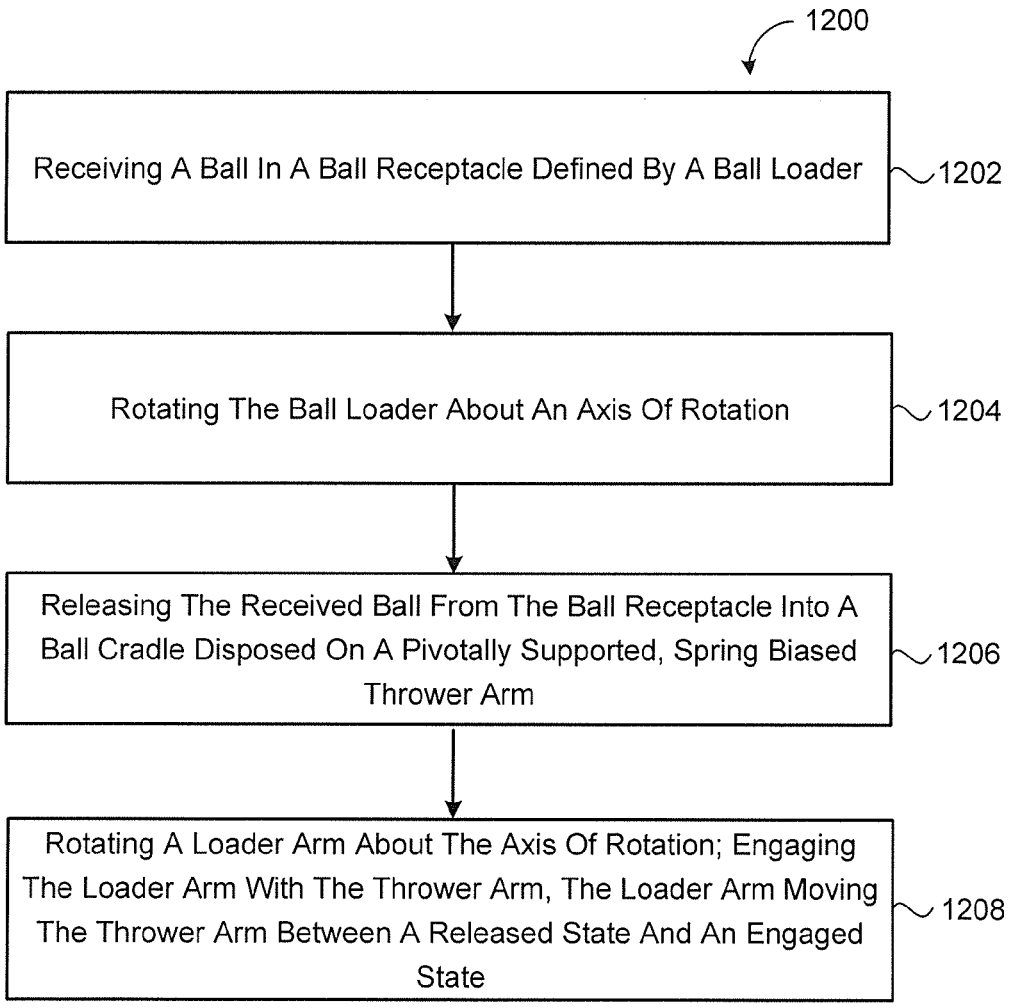
1200
Receiving A Ball In A Ball Receptacle Defined By A Ball Loader
1202
Rotating The Ball Loader About An Axis Of Rotation
1204
Releasing The Received Ball From The Ball Receptacle Into A Ball Cradle Disposed On A Pivotally Supported, Spring Biased Thrower Arm
1206
Rotating A Loader Arm About The Axis Of Rotation; Engaging The Loader Arm With The Thrower Arm, The Loader Arm Moving The Thrower Arm Between A Released State And An Engaged State
1208

FIG. 12

BALL LAUNCHING DEVICE

CROSS REFERENCE TO RELATED APPLICATIONS

This U.S. patent application is a Continuation Application of U.S. patent application Ser. No. 14/565,870 filed on Dec. 10, 2014 (now U.S. Pat. No. 9,067,119 issued on Jun. 30, 2015), which claims priority under 35 U.S.C. §119(e) to U.S. Provisional Application Ser. No. 61/915,779, filed on Dec. 13, 2013, which are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

This disclosure relates to a ball throwing device that launches a ball.

BACKGROUND

Several sports, such as tennis, baseball, softball, volleyball, among others, require a player to hit a ball either with a racquet, a bat, or their hand. Players often practice hitting the ball. Generally, two players are necessary to practice these sports. One player throws the ball, and another player catches the ball or hits the ball back to the first player. Sometimes, a player wants to practice hitting a ball and does not have another player to throw the ball. Therefore, if a player wants to improve his or her ball hitting skills, a player needs the assistance of another player and cannot play by himself or herself. Moreover, the other player might not be skilled in the game and might lack the techniques of throwing the ball correctly.

Tennis is usually an individual sport where two teams play against each other. Each team may include a single player (singles) or two players (doubles). The object of the game is for each player to play the ball in such a way that the opponent is not able to play a good return. Each player has a racquet strung with cord to strike a ball thrown by the opponent. The ball is usually a hollow rubber ball covered with felt. Each player stands on one side of a net that divides a court, and the ball is thrown between the players over the net. In tennis, the serve is generally the most challenging part of the game. The tennis serve consists of a player throwing the ball in the air and swinging the racquet toward the opponent on the other side of the court.

SUMMARY

One aspect of the disclosure provides a ball launcher including a base, a thrower arm, a ball loader, and a loader arm. The thrower arm is pivotally supported by the base and has a first end and a second end. The first end defines a ball cradle. The thrower arm is spring biased in a pivoting direction. The ball loader is rotatably supported by the base and defines an axis of rotation and a ball receptacle. The loader arm is rotatably supported about the axis of rotation and extends away from the axis of rotation. The ball loader and the loader arm are arranged so that as the ball loader rotates, the ball receptacle releases a received ball into the ball cradle, and the loader arm engages and moves the thrower arm between a released state and an engaged state.

Implementations of the disclosure may include one or more of the following optional features. In some implementations, the ball loader releases a received ball from the ball receptacle into the ball cradle before the loader arm engages the thrower arm. The ball loader may release a received ball from the ball receptacle into the ball cradle after the loader arm engages the thrower arm and before the loader arm moves the thrower arm from its engaged state to its released state. The loader arm may extend perpendicular to the axis of the rotation of the ball loader. Additionally or alternatively, the loader arm may have a variable length or width.

In some examples, the ball launcher includes a shaft rotatably supported by the base and a motor coupled to the shaft. The ball loader is disposed on the shaft. The ball launcher may also include a thrower stop arranged to limit pivotal movement of the thrower arm to set a ball release position of the thrower arm. Additionally or alternatively, the thrower arm may be pivotally supported between its first and second ends. The thrower stop may be arranged to receive the second end of the thrower arm. In some examples, the ball launcher includes one or more legs supporting the base. Each leg has an adjustable length to tilt the base with respect to a supporting surface.

Another aspect of the disclosure provides a method of launching a ball. The method includes loading a ball into a ball receptacle defined by a ball loader rotatably supported about an axis of rotation and rotating the ball loader about the axis of rotation. As the ball loader rotates, the ball receptacle releases the received ball from the ball receptacle into a ball cradle defined by a pivotally supported, spring biased thrower arm. A loader arm is disposed on the ball loader and extending away from the axis of rotation engages the thrower arm, moving the thrower arm between a released state and an engaged state.

In some implementations, the ball receptacle releases the received ball into the cradle before the loader arm engages the thrower arm. The method may include the ball receptacle releasing the received ball from the ball receptacle into the ball cradle after the loader arm engages the thrower arm and before the loader arm moves the thrower arm from its engaged state to its released state.

In some examples, the loader arm extends perpendicular to the axis of rotation. Additionally or alternatively, the method may include adjusting a length of the loader arm to alter an angular pivot range of the thrower arm while engaged by the loader arm. The method may further include adjusting a position of the loader arm along the axis of rotation to alter an angular pivot range of the thrower arm while engaged by the loader arm.

In some implementations, the method includes limiting pivotal movement of the thrower arm to set a ball release position of the thrower arm. Additionally or alternatively, the method may further include adjusting a thrower stop. The thrower stop is arranged to limit pivotal movement of one end of the thrower arm. The thrower arm has first and second ends and is pivotally supported between its first and second ends.

Yet another aspect of the disclosure provides a method of launching a ball. The method includes receiving a ball in a ball receptacle defined by a ball loader, rotating the ball loader about an axis of rotation, and releasing the received ball from the ball receptacle into a ball cradle disposed on a pivotally supported spring biased thrower arm. The method also includes rotating a loader arm about the axis of rotation, engaging the loader arm with the thrower arm. The loader arm moves the thrower arm between a released state and an engaged state.

In some examples, the method further includes releasing the received ball from the ball receptacle into the ball cradle before the loader arm engages the thrower arm. The method may also include releasing the received ball from the ball receptacle into the ball cradle after the loader arm engages

the thrower arm and before the loader arm moves the thrower arm from its engaged state to its released state.

The loader arm may extend perpendicular to the axis of rotation. Additionally or alternatively, the method may include adjusting a length of the loader arm to alter an angular pivot range of the thrower arm while engaged by the loader arm.

The method may also include adjusting a position of the loader arm along the axis of rotation to alter an angular pivot range of the thrower arm while engaged by the loader arm. The method may include limiting pivotal movement of the thrower arm to set a ball release position of the thrower arm. Additionally or alternatively, the method may include adjusting a thrower stop arranged to limit pivotal movement of one end of the thrower arm. The thrower arm has first and second ends and is pivotally supported between its first and second ends.

Another aspect of the disclosure provides a ball launcher including a base defining a transverse axis, a fore-aft axis, and a central vertical axis, wherein the transverse axis and the fore-aft axis form an X-Y plane substantially parallel to a supporting surface. The ball launcher further includes a thrower arm having a first end and a second end the first end defining a ball cradle. An arm holder is disposed on the base and pivotally supports the second end of the thrower arm about a first axis of rotation substantially parallel to the transverse axis, the thrower arm spring biased about the first axis of rotation between a ball receiving or releasing position and an engaged position. A rotating shaft defines a second axis of rotation and has a front end and a back end. The second axis of rotation is substantially parallel to the fore-aft axis. A ball loader is coupled to the front end of the rotating shaft for common rotation about the second axis of rotation, the ball loader defining a ball receptacle sized and shaped to receive and releasably support a ball. The ball launcher further includes a loader arm releasably connected to the rotating shaft for common rotation about the second axis of rotation when the rotating shaft rotates, the loader arm defining a longitudinal axis substantially perpendicular to the second axis of rotation of the shaft and having a length extending away from the rotating shaft. The rotating shaft, the ball loader and the loader arm are arranged so that as the rotating shaft rotates about the second axis of rotation: the ball loader rotates in unison about the second axis of rotation to release a received ball from the ball receptacle into the ball cradle while the thrower arm is in the ball receiving position; and the loader arm rotates in unison about the second axis of rotation to engage and move the thrower arm from the ball receiving position to the engaged position when the loader arm contacts a contact surface associated with the thrower arm.

In some implementations, the ball receptacle releases the received ball into the cradle before the loader arm engages the thrower arm. In some examples, the ball loader releases a received ball from the ball receptacle into the ball cradle after the loader arm engages the thrower arm and before the loader arm moves the thrower arm from its ball receiving position to its engaged position. The loader arm may have a variable length and/or a variable position about the rotating shaft along the second axis of rotation.

In some examples, the contact surface associated with the thrower arm includes a top surface of the thrower arm. The contract surface associated with the thrower arm may be supported by an engagement member disposed on the thrower arm. In some examples, the contact surface includes a roller rotatably supported by the engagement member. The contact surface may be angled with respect to the longitudinal axis of the thrower arm. In some examples, the engagement member has a variable position about the thrower arm along the longitudinal axis of the thrower arm. In some implementations, a contact point between the loader arm and the contact surface has a variable height from the thrower arm with respect to the center vertical axis of the base based upon a position of the engagement member about the thrower arm along the longitudinal axis of the thrower arm and a position of the loader arm about the rotating shaft along the second axis of rotation.

In some examples, the ball launcher includes a motor coupled to the back end of the rotating shaft for common rotation about the second axis of rotation when the motor rotates. A thrower stop may be arranged to limit pivotal movement of the thrower arm to set the ball receiving or releasing position of the thrower arm. In some implementations, a spring support is disposed on the second end of the thrower arm, the thrower stop is disposed between the spring support and the base, and one or more springs connect the spring support to one of the thrower stop or the base. The springs bias the thrower arm in the ball receiving or releasing position when the loader arm and the thrower arm are disengaged and the ball cradle is unoccupied. The thrower stop may telescope between a retracted position and an expanded position to set the ball receiving or releasing position of the thrower arm. The ball launcher may further include one or more legs supporting the base, each leg having an adjustable length to tilt the base with respect to the supporting surface.

Yet another aspect of the disclosure provides a method of launching a ball. The method includes setting a ball receiving or releasing position of a thrower arm pivotally supported by an arm holder about a first axis of rotation. The thrower arm is spring biased about the first axis of rotation between the ball receiving or releasing position and an engaged position. The method also includes loading a ball into a ball receptacle defined by a ball loader coupled to a rotating shaft for common rotation about a second axis of rotation defined by the rotating shaft when the rotating shaft rotates. The second axis of rotation is substantially perpendicular to the first axis of rotation. The method also includes rotating the ball loader and the rotating shaft in unison about the second axis of rotation. As the ball loader rotates, the ball receptacle releases the received ball from the ball receptacle into a ball cradle connected to the thrower arm and a loader arm moves the thrower arm from the ball receiving position to the engaged position when the loader arm contacts a contact surface associated with the thrower arm. The loader arm is releasably connected to the rotating shaft for common rotation about the second axis of rotation when the rotating shaft rotates and defining a longitudinal axis substantially perpendicular to the second axis of rotation of the rotating shaft.

In some implementations, the ball receptacle releases the received ball into the cradle before the loader arm engages the thrower arm. In other implementations, the ball receptacle releases the received ball from the ball receptacle into the ball cradle after the loader arm engages the thrower arm and before the loader arm moves the thrower arm from its ball receiving position to its engaged position.

In some examples, the method also includes adjusting a position of the loader arm about the rotating shaft along the second axis of rotation to alter an angular pivot range of the thrower arm while engaged by the loader arm. The method may also include limiting pivotal movement of the thrower arm to set the ball receiving or releasing position of the thrower arm. In some examples, the method also includes

adjusting a thrower stop arranged to limit pivotal movement of the thrower arm, the thrower arm having a first end connected to the ball cradle and a second end rotatably supported by the arm holder about the first axis of rotation. In some implementations, the method also includes connecting one or more springs between a spring support disposed on the second end of the thrower arm and one of the thrower stop or the base, the springs biasing the thrower arm in the ball receiving or releasing position when the loader arm and the thrower arm are disengaged and the ball cradle is unoccupied.

The details of one or more implementations of the disclosure are set forth in the accompanying drawings and the description below. Other aspects, features, and advantages will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIGS. **1** and **2** are schematic views of an exemplary ball launching device.

FIG. **3** is a schematic side view of an exemplary ball launching device.

FIGS. **4** and **5** are schematic views of an exemplary ball launching device.

FIG. **6** is a schematic side view of an exemplary ball launching device.

FIG. **7** is a schematic view of an exemplary ball launching device as a ball loader receives a ball.

FIG. **8** is a schematic view of the exemplary ball launching device of FIG. **7** as a ball cradle receives the ball from the ball loader.

FIG. **9** is a schematic view of the exemplary ball launching device of FIG. **7** as a thrower arm pulls downwards before releasing the ball.

FIGS. **10**A and **10**B are schematic views of the exemplary ball launching device of FIG. **7** as the thrower arm launches the ball.

FIG. **11** is a schematic view of an exemplary arrangement of operating a ball launching device.

FIG. **12** is a schematic view of an exemplary arrangement of operating a ball launching device.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

In games that entail hitting a ball, players usually struggle with tossing the ball to a desired location before hitting the ball. For example, tennis players may struggle with tossing a ball to a desired location above their head before hitting the ball at a desired height. In some instances, it is desirable for a player to practice tossing the ball separately from hitting the ball. This allows the player to develop muscle memory and confidence in one aspect of the serve separately from another aspect of the serve.

Referring to FIGS. **1-6**, a ball launcher **100** helps players **10** practice hitting a ball **12** tossed in a consistent manner. For example, the ball launcher **100** can help a player **10** practice hitting a tossed tennis ball **12** during a serve by isolating two aspects of the serve (tossing and hitting). Although the examples herein are described with reference to practicing hitting a tennis ball with a racquet, the ball launcher **100** may be used and configured for any type of sport that includes hitting or striking a ball (e.g., baseball, softball, volleyball, etc.). The ball launcher **100** is a lightweight and portable device capable of being carried around by a user **10** (e.g., trainer or a player) when practicing. The ball launcher **100** allows a player **10** to practice several of his/her tennis shots, including but not limited to serving, forehand, backhand, volley, slice, smash (overhead), and lob.

The ball launcher **100** includes a base **102**, which may be disposed on one or more legs **104**. The base **102** defines a transverse axis X, a fore-aft axis Y, and a central vertical axis Z. The transverse axis X and the fort-aft axis Y form an X-Y plane substantially parallel to a ground X_G-Y_G plane of the ground surface **14** when the legs **104** are each at an equal distance D_L from the ground surface **14**. In some examples, the legs **104** are adjustable, allowing a user **10** to adjust the distance D_L of each leg **104** from the ground surface **14**. In such examples, the base plane, i.e., X-Y plane, and the ground X_G-Y_G plane intersect. The user **10** may decide to adjust one or more legs **104** resulting in an uneven base **102** with respect to the ground plane X_G-Y_G plane. Adjusting a tilt of the base **102** by adjusting the distance D_L of the legs **104** from the ground surface **14** is one of the ways to adjust a launch point LP of a ball **12** from a ball cradle **110** with respect to the base **102** or the ground surface **14**.

The base **102** supports an arm holder **106** disposed on the base **102**. The arm holder **106** holds and pivotally supports a thrower arm **108**. The thrower arm **108** is configured to launch a ball **12** and is spring biased in a pivoting direction. The thrower arm **108** has a first end **108***a* and a second end **108***b*. A ball cradle **110** is disposed on, or connected to, the first end **108***a* of the thrower arm **108**. In some examples, as shown in FIGS. **1-3**, the second end **108***b* of the thrower arm **108** is releasably attached to the arm holder **106**. In other examples, as shown in FIGS. **4-6**, the second end **108***b* of the thrower arm **108** is pivotally supported to the arm holder **106** about a first axis of rotation R_X via an axle **218**, wherein the thrower arm **108** may move upward or downward about the pivot point at the first axis of rotation R_X. The arm holder **106** may include a ramped surface **206**, as shown in FIG. **4**, limiting movement of the thrower arm **108** in a downward direction L when the thrower arm **108** pivots in a counter-clockwise direction CW about the first axis of rotation R_X. The ball cradle **110** may be any shape (e.g., square, round, triangle) capable of receiving a ball **12** and holding the ball **12** in the ball cradle **110** until the ball **12** is launched. The ball cradle **110** holds the ball **12** during the movement of the thrower arm **108** in a downward direction L (explained below).

In some implementations, a thrower stop **112** limits the pivotal movement of the thrower arm **108** to a ball releasing position of the thrower arm **108**, which defines the launch point LP of a ball **12** from the ball cradle **110**. In some implementations, as shown in FIGS. **1-3**, the thrower stop **112** is disposed between the arm holder **106** and the thrower arm **108**. Referring to FIGS. **4-6**, in some implementations, a spring support **214** is disposed on the second end **108***b* of the thrower arm **108** and the thrower stop **112** is disposed between the base **102** and the spring support **214**. In the examples shown, a first end **214***a* of the spring support **214** is disposed on the second end **108***b* of the thrower arm **108**, and the thrower stop **112** is disposed between a second end **214***b* of the spring support **214** and the base **102**. In some implementations, the thrower stop **112** telescopes between a retracted position and an expanded position about the vertical axis Z defined by the base **102**.

In some implementations, as shown in FIGS. **1-3**, a spring tower **114** is disposed on the base **102** and defines an opening **116** allowing the thrower arm **108** to pass therethrough. The spring tower **114** includes a top portion **114***a*

and a bottom portion **114***b*. In some examples, one or more spring locators **117** are disposed on the top portion **114***a* of the spring tower **114**. The spring locators **117** connect a spring **118** between the spring tower **114** and the thrower arm **108**. One or more spring locators **117** may also be disposed on the thrower arm **108** to connect to the spring **118** (a.k.a. thrower arm spring). In some examples, the spring tower **114** includes spring locators **117** in its top portion **114***a* (as shown), allowing one or more springs **118** to bias the thrower arm **108** upwards. The thrower arm **108** moves within the opening **116** of the spring tower **114** as it is biased upwards.

Referring to FIGS. **4-6**, in some implementations, the spring tower **114** is omitted and the springs **118** are connected between the spring support **214** and the thrower stop **112** or base **102**. In some examples, one or more spring locators **117** are disposed proximate to the second end **214***b* of the spring support **214** and connect the spring **118** between the spring support **214** and the thrower stop **112** or the base **102**. One or more spring locators **117** may also be disposed on the thrower stop **112** or the base **102**. In some examples, the spring support **214** includes spring locators **117** adjacent to its second end **214***b* (as shown), allowing one or more springs **118** to bias the thrower arm **108** upwards. The thrower arm **108** pivots about the first axis of rotation R_X between the thrower stop **112** and the ramped surface **206** of the arm holder **106**.

As shown in FIGS. **1-6**, the ball launcher **100** includes a loader stand **120** disposed on the base **102** for supporting a support arm **122** having a front portion **122***a*, a middle portion **122***b*, and an end portion **122***c*. In some examples, as shown in FIGS. **4-6**, a loader support **220** disposed on the base **102** additionally supports an end of the support arm associated with the front portion **122***a*. The front portion **122***a* includes a ball loader **130**. The ball loader **130** includes at least one ball receptacle **132** sized to receive a ball **12** from a first location (e.g., a ball feeder or manually by a user **10**) and drop the ball **12** into the ball cradle **110**. The perimeter edge of the ball receptacle **132** may include a radius that assist in guiding the ball **12** to the ball receptacle **132** when the ball **12** is received from the first location. In some examples (as shown in FIGS. **4-6**), the ball cradle **110** includes one or more ramping features **110***a* that guide the ball **12** into the ball cradle **110** when the ball **12** is dropped from the ball receptacle **132** of the ball loader **130**. Additionally or alternatively (as shown in FIGS. **4-6**), one or more ball stops **110***b* may be disposed on the ball cradle **110**, the ball stops **110***b* stopping the ball **12** from rolling out of the ball cradle **110**. The ball loader **130** shown has a cylindrical shape; however, other shapes may also be possible such that the ball loader **130** can rotate and receive a ball **12**.

The end portion **122***c* of the support arm **122** includes a motor **140**. The motor **140** may be a stepper motor or a servo motor. A stepper motor is a brushless DC electric motor that divides a full rotation into a number of equal steps. The motor can move and hold a position at one of the steps without any feedback sensor (i.e., without providing any feedback to its position); while a servo motor is a rotary actuator that allows for the precise control of angular position, velocity, and acceleration. The servo motor includes a motor that is coupled to a sensor for position feedback and a controller. The middle portion **122***b* includes a shaft **150** (e.g., rotating shaft) connecting the ball loader **130** to the motor **140**. Thus, a front end **150***a* of the shaft **150** connects to the ball loader **130** and a back end **150***b* of the shaft **150** connects to the motor **140**. In some examples, as shown in FIGS. **4-6**, the front end **150***a* of the shaft **150** is rotatably supported by the loader support **220** and the ball loader **130** is disposed on, and therefore coupled to, the shaft **150** for common rotation; however, the ball loader **130** may be rotatably supported by the loader support **220** and coupled to the front end **150***a* of the shaft **150** for common rotation. In an active state, the motor **140** rotates about a second axis of rotation R_Y defined by the shaft **150** that extends from the front portion **122***a* through the middle portion **122***b* to the end portion **122***c* of the support arm **122**. The rotation of the motor **140** causes the shaft **150** and therefore the ball loader **130** to rotate in the same direction about the second axis of rotation R_Y. In some examples, the ball loader **130** and the shaft **150** rotate in a clockwise direction CW if the thrower arm **108** is positioned on the right side of the support arm **122** (as shown in the figures). The ball loader **130** and the shaft **150** may rotate in a counterclockwise if the thrower arm **108** is positioned to the left of the support arm **122**. As described, the ball launcher **100** includes a motor **140**; however in some implementations, the ball launcher **100** includes a manual rotator **142**, which as shown is disposed on ball loader **130**; however, the manual rotator **142** may be disposed on the end portion **122***c* of the support arm **122**. The manual rotator **142** allows a user **10** to manually rotate the support arm **122** causing the release of the ball **12** from the ball receptacle **132** and causing a loader arm **160** to engage with the thrower arm **108** when the loader arm **160** contacts a contact surface **208** associated with the thrower arm **108**. In some examples, the motor **140** may be initiated by a foot pedal or a wind-up crank.

The loader arm **160** is disposed on the support arm **122**. In some examples, the loader arm **160** is releasably connected to the shaft **150** for common rotation about the second axis of rotation R_Y when the shaft **150** rotates. In some examples, the loader arm **160** has a variable position about the shaft **150** along the second rotating axis R_Y. The shaft **150** may include a keyway slot for securing the loader arm **160** to the shaft **150** and preventing the loader arm **160** from disengaging from the shaft **150**. The keyway holder may be releasably connected to the shaft **150** for tightening the engagement between the shaft **150** and the loader arm **160**. A user **10** may untighten the keyway holder to move/translate the loader arm **160** about the shaft **150**. The loader arm **160** may move/translate along the second rotating axis R_Y to a position on the shaft **150** desired by the user **10** for securing the loader arm **160** to the shaft **150**. The variable position of the loader arm **160** provided by moving the loader arm **160** about the shaft **150** alters a contact point **908** (FIG. **9**) between the loader arm **160** and the contact surface **208** associated with the thrower arm **108** (discussed below), which in turn affects a height H_{ball} that the ball **12** is launched from. In some implementations, the loader arm **160** moves about the shaft **150** when a user **10** rotates the manual rotator **142**.

In some examples, the loader arm **160** is releasably connected to the ball loader **130**. The loader arm **160** may include a connector **162** to secure the loader arm **160** to the ball loader **130**. As shown, in FIG. **2**, the loader arm **160** includes first and second connectors **162***a*, **162***b*. Moreover, and as shown, the loader arm **160** is substantially in contact with the ball loader **130**. In some examples, the connectors **162** are adjustable, allowing the ball loader **130** to be separated a threshold distance from the loader arm **160**. Adjusting the position of the loader arm **160** about the shaft

150 or from the ball loader 130 is another method a user 10 may consider to adjust the launch point LP of the ball 12 from the ball cradle 110.

The loader arm 160 defines a longitudinal axis X_{arm} substantially perpendicular to the second axis of rotation R_Y and has a length L_{arm} along its longitudinal axis X_{arm} that extends and reaches the contact surface 208 associated with the thrower arm 108. When the loader arm 160 is connected (e.g., secured) to the shaft 150 (or ball loader), the loader arm 160 rotates in unison with the shaft 150 and the ball loader 130 about the second axis of rotation R_Y. The loader arm 160 is a mechanical linkage transforming rotary motion from the loader arm 160 about the second axis of rotation R_Y into linear motion by the thrower arm 108 in the downward direction L (about the first axis of rotation R_X). For instance, the loader arm 160 engages the thrower arm 108 when the loader arm 160 contacts the contact surface 208, by applying a force in the downward L direction as the loader arm 160 rotates. Therefore, the length L_{arm} of the loader arm 160 is at least capable of reaching the contact surface 208 so that the loader arm 160 reaches and pushes the thrower arm 108 downwards as it rotates. Moreover, a greater length of the loader arm L_{arm} allows for a longer engagement time between the loader arm 160 and the thrower arm 108 when the loader arm 160 contacts the contact surface 208, causing the loader arm 160 to push the thrower arm 108 a greater distance in the downward direction L.

In some examples, the loader arm 160 is rotatably supported about the second axis of rotation R_Y and extends away from the axis of rotation R. The loader arm 160 may extend perpendicular to the second axis of rotation R_Y of the ball loader 130 or at any other angle. As shown in FIGS. 1-3, the loader arm 160 may have a rectangular shape with the top and bottom portions of the rectangular shape being a square or a rectangular shape; however, the loader arm 160 may have a cylindrical shape. In some examples, the loader arm 160 has a tip attached thereon. The tip may be a round tip for reducing the friction between the loader arm 160 and the contact surface 208 associated with the thrower arm 108 during the engagement phase. As shown in FIGS. 1-3, the contact surface 208 corresponds to a top surface of the thrower arm 108.

Referring to FIGS. 4-6, in some implementations, the ball launcher 100 includes an engagement member 228 disposed on the top surface of the thrower arm 108. The engagement member 228 may support the contact surface 208 at a height H_{CS} above the thrower arm 108. The contact surface 208 may be rounded to reduce friction when the loader arm 160 contacts the contract surface 208 and/or to assist in disengaging the loader arm 160 from the contact surface 208 during a disengagement phase. In some examples, the contact surface 208 is a roller rotatably supported by the engagement member 228 about a third axis of rotation R_{YZ}. When the loader arm 160 contacts the roller 208 as the loader arm 160 rotates about the second axis of rotation R_Y, the loader arm 160 causes the roller 208 to rotate as the loader arm 160 applies the force in the downward L direction to the thrower arm 108.

In some examples, the contact surface 208 supported by the engagement member 228 is angled with respect to a longitudinal axis Y_{TA} defined by the thrower arm 108. Angling the contract surface 208 allows a height of the contact surface 208 above the thrower arm 108 to be variable between a first height H_{CS_a} and a lower second height H_{CS_2}. Accordingly, the contact point 908 between the loader arm 160 and the contact surface 208 may be altered to occur at any height between H_{CS_a} and H_{CS_b} of the contact surface 208, which in turn affects a height H_{ball} that the ball 12 is launched from. As discussed above, moving the loader arm 160 about the shaft 150 alters the contract point between the loader arm 160 and the contact surface 208. Additionally or alternatively, the engagement member 228 disposed on the thrower arm 108 may move along the longitudinal axis Y_{TA} of the thrower arm 108, For example, the thrower arm 108 may include a keyway slot for securing the engagement member 228 to the thrower arm 108 and preventing the engagement member 228 from disengaging from the thrower arm 108. The keyway holder may be releasably connected to the thrower arm 108 for tightening the engagement between the thrower arm 108 and the engagement member 228. The user 10 may untighten the keyway holder to move/translate the engagement member 228 about the thrower arm 108. The engagement member 228 may move/translate about the thrower arm 108 to secure the engagement member 228 to the thrower arm 108 at a position desired by the user 10. The movement of the engagement member 228 about the thrower arm 108 alters the contact point 908 between the loader arm 160 and the contact surface 208 to occur at any height between H_{CS_a} and H_{CS_b} of the contact surface 208, which in turn affects a height H_{ball} that the ball 12 is launched from. For example, the duration of contract between the loader arm 160 and the contact surface 208 increases as the contract point approaches the first height H_{CS_a} on the contact surface 208. Thus, increasing the duration of contact between the loader arm 160 and the contact surface 208 results in the magnitude of force applied to the thrower arm 108 in the downward direction L about the pivot point at the first axis of rotation R_X to be increased. In some implementations, the loader arm 160 moves about the shaft 150 when a user 10 rotates the manual rotator 142.

In some implementations, as shown in FIGS. 4 and 5, the loader arm 160 has a lobe shape and includes a ramped engagement surface 260 and a nose portion 262 for contacting the contact surface 208 associated with the thrower arm 108 as the loader arm 160 rotates about the second axis of rotation R_Y. The nose portion 262 is centered about the longitudinal axis X_{arm} of the loader arm 160 and the ramped engagement surface 260 extends from the nose portion 262 at an angle respective to the longitudinal axis X_{arm}. When the loader arm 160 engages the thrower arm 108, the contact point 908 between the loader arm 160 and the contract surface 208 traverses along the ramped engagement surface 260 to the nose portion 262 as the loader arm 160 rotates about the second axis of rotation R_Y. The ramped engagement surface 260 allows the loader arm 160 to smoothly push the thrower arm 108 in the downward direction L about the pivot point at the first axis of rotation R_X. In some examples, the angle of the ramped engagement surface 260 with respect to the longitudinal axis X_{arm} of the loader arm 160 is selected to achieve a desired timing from when the loader arm 160 initially engages the thrower arm 108 to when the loader arm 160 disengages from the thrower arm 108, thereby causing the thrower arm 108 to bias in an opposite upward direction to launch and release the ball 12 from the ball cradle 110 and into the environment.

Referring to FIGS. 1-6, the ball loader 130 and the loader arm 160 are arranged so that when the ball loader 130 rotates, it causes the ball receptacle 132 to release a received ball 12 into the ball cradle 110. In some examples, once the ball loader 130 releases the received ball 12 from the ball receptacle 132 into the ball cradle 110, the loader arm 160 engages and moves the thrower arm 108 from a first biased position (e.g., a released state) and an engaged position. The

first biased position refers to a ball receiving or releasing position, wherein the ball receiving position is associated with receiving the ball **12** from the ball receptacle **132** into the ball cradle **110** and the ball releasing position is associated with launching the received ball **12** from the ball cradle **110** to environment subsequent to the engaged position after the loader arm **160** disengages from the thrower arm **108**. In other examples, the ball loader **130** releases the received ball **12** from the ball receptacle **132** into the ball cradle **110** after the loader arm **160** engages the thrower arm **108**, but before the loader arm **160** moves the thrower arm **108** from its ball receiving position (e.g., first biased position) to its engaged position. As shown, a loader arm **160** is positioned on an opposite end of the ball receptacle **132** (i.e., the loader arm **160** extends away from the ball receptacle **132**).

Referring to FIGS. **7-10**B, operations for launching a ball **12** to the environment are shown. While FIGS. **7-10**B are described with reference to the arrangement of the ball launcher **100** shown in FIGS. **1-3**, the operations are equally applicable to the arrangement of the ball launcher **100** shown in FIGS. **4-6**. In some examples, a user **10** or a ball feeder **400** feeds the ball receptacle **132** of the ball loader **130** a ball **12** in a ball receiving position as shown in FIG. **7**. In the example shown, the ball feeder **400** is a frustoconical shape and includes a helical ramp around the circumferential surface for feeding one or more balls **12** to the to the ball receptacle **132** in the ball receiving position. In other examples, the ball feeder **400** is a hopper for holding one or more balls **12** and feeding one ball **12** at a time to the ball receptacle **132** in the ball receiving position. The hopper may have a frustoconical shape or any other shape for facilitating balls to be fed to the ball receptacle **132**. In some examples, the thrower arm **108** defines a longitudinal axis Y_{TA}. The longitudinal axis Y_{TA} of the thrower arm **108** is substantially parallel to the fore-aft axis Y of the base **102** when the thrower arm **108** is in the ball receiving position. The ball receiving position allows the ball receptacle **132** to receive the ball **12**. When the thrower arm **108** is spring biased and the ball cradle **110** is not supporting a ball **12**, the thrower arm **108** is in a first biased position, biased upwards (FIG. **7**) due to the springs **118** that are preventing the thrower arm **108** from moving in a downward direction L. When the ball cradle **110** receives and is supporting the ball **12**, the thrower arm **108** is in a second biased state (FIG. **8**) due to the additional weight of the ball **12**; the springs **118** maintain the thrower arm **108** in this second biased position despite the weight of the ball **12** that is applying a downward force in the downward direction L. The motor **140** (e.g., manual or automatic) rotates the ball loader **130** causing the ball **12** to drop on the ball cradle **110** of the thrower arm **108**.

FIG. **8** shows the ball receptacle **132** releasing the ball **12** to the ball cradle **110**. The ball receptacle **132** is positioned at a height from the base **102** greater than the height H of the ball cradle **110** from the base **102** allowing the ball **12** to roll out of the ball receptacle **132** by gravitational force. The support arm **122** continues to rotate after the ball receptacle **132** drops the ball **12** in the ball cradle **110** causing the loader arm **160** to contact the contract surface **208** associated with the thrower arm **108**, and thereby engage with the thrower arm **108**. The engagement of the loader arm **160** and the thrower arm **108** causes the thrower arm **108** to move between its second biased position (FIG. **8**) to a third biased position or an engaged position (FIG. **9**). The engagement between the loader arm **160** and the thrower arm **108** causes the loader arm **160** to push the thrower arm **108** in a downward direction L about a pivot point towards the base **102** until the rotation of the support arm **122** prevents the loader arm **160** from reaching the thrower arm **108**. Referring to FIGS. **4-6**, in some implementations, the loader arm **160** pushes the thrower arm **108** in the downward direction L about the first axis of rotation R_X at the pivot point provided by the axle **218** rotatably supporting the second end **108***b* of the thrower arm **108** to the arm holder **106**.

FIG. **9** shows the second end **108***b* of the thrower arm **108** shifting away from the thrower stop **112** as the thrower arm **108** moves in the downward direction L about the pivot point. The longitudinal axis Y_{TA} of the thrower arm **108** shifts to a transposed longitudinal axis Y'_{TA} having an angle α there between when the loader arm **160** applies force to the thrower arm **108** in the downward direction L. When the loader arm **160** disengages from the thrower arm **108**, the thrower arm **108** transitions between its third biased state to a released state (e.g., ball releasing position (FIG. **10**A)). The released state corresponds to the first biased position. During the released state, the thrower arm **108** moves in a direction opposite the downward direction L, i.e., in an upward direction about the pivot point, to reach a ball release point LP of the thrower arm **108**. During the ball release position, the thrower arm **108** launches the ball **12** to the environment. Moreover, during the ball release position, the thrower stop **112** controls the angle α that the ball **12** may be released at. The ball release position is set by the thrower stop **112**; therefore, the height H from the base **102** at which the ball **12** is released and the ball release point LP is determined by the thrower stop **112**, since the thrower stop **112** limits the movement of the thrower arm **108**. In some examples, the ball **12** is launched from the ball cradle **110** towards the external environment and may reach a height of 20 feet or more. When the longitudinal axis Y_{TA} of the thrower arm **108** returns to its substantially parallel position to the fore-aft axis Y of the base **102** at the ball release position, the ball **12** is released at a substantially straight angle with respect to the base X-Y plane. However, any adjustment to the thrower stop **112** modifies the ball release point LP of the ball **12**. In other examples, when the legs **104** are adjusted resulting in an angled base **102** with respect to the surface plane X_G-Y_G, then the ball cradle **110** releases the ball **12** at a 90 degree angle with respect to the base **102**, which is at an angle from the X_G-Y_G surface plane.

FIG. **10**A shows a user **10** waiting to hit the ball **12** with a racquet **11** as the ball **12** is launched to the environment. FIG. **7**B shows the user **10** hitting the ball **12** with the racquet **11** after the ball **12** is launched in the environment and then bounces off the ground. Therefore, the user **10** may hit the ball **12** as the ball **12** is being launched into the environment or at any subsequent time.

In some examples, the manual rotator **142** may be used as a visual reference point allowing the user **10** to know the ball launcher **100** will launch the ball **12**. Additionally or alternatively, a light indicator **144** may be disposed on the ball loader **130** (as shown in FIG. **10**B) or at any location on the ball launcher **100** that is visible to the user **10**. The light indicator **144** may flash on and off or change color when the ball launcher **100** is getting ready to launch the ball **12**. In some examples, the ball launcher **100** includes a speaker **146** (FIG. **10**B) that produces a sound alerting the user **10** that the ball launcher **100** is getting ready to launch the ball **12**. The sound may change as the ball launcher **100** gets closer to releasing the ball **12**.

In some examples, the ball launcher **100** includes a power button **170** supported by the base **102** for activating or de-activating the ball launcher **100**. A rheostat **172** is supported by the base **102** and allows a user **10** to control the

frequency of the number of balls **12** launched by the thrower arm **108**. The rheostat **172** is an adjustable resistor that changes the resistance in an electric circuit. The rheostat **172** is in electrical communication with the motor **140** and controls the speed of the motor **140**, which in turn controls the frequency that the ball loader **130** releases a ball **12** in the ball cradle **110** and the loader arm **160** engages the ball launcher **100**. The rheostat **172** has resistance elements that can be metal wire or ribbon, carbon, or a conducting liquid. The rheostat **172** is a two-terminal variable resistor; however, a three-terminal potentiometer may be used having one unconnected terminal if the application is a low-power application.

In some implementations, a user **10** may adjust the height H of the ball cradle **110** from the base **102**. A height controller (not shown) supported by the thrower arm **108** or the spring tower **114** controls the height H of the launching ball cradle **110** from the base **102**. Therefore, a user **10** may increase the height H of the ball cradle **110** and thus increase the distance and time of engagement between the loader arm **160** and the thrower arm **108**. The user **10** may decrease the height H of the ball cradle **110** from the base **102**, thus decreasing the engagement time and travel distance between the thrower arm **108** and the loader arm **160**. In addition, the position of the loader arm **160** on the shaft **150** may also affect the engagement duration and travel distance between the thrower arm **108** and the loader arm **160**; the closer the loading arm is to the ball loader **130**, the greater the engagement time is because the distance that the loader arm **160** pushes in the downward direction L is also greater. The greater the distance and duration of engagement, the loader arm **160** applies more force causing the ball **12** to launch at a faster speed. The height controller may be a thumbscrew or any other screw that allows a user **10** to adjust it by loosening or tightening the screw by hand. The height controller may control the height of the arm holder **106** or the spring tower **114** or both.

Referring to FIGS. **1-6**, the loader arm **160** is shown to be positioned behind the ball loader **130** on the shaft **150**, extending at opposite ends from the ball receptacle **132** about the second axis of rotation R_Y; however, different structures may also be possible. For example, the ball loader **130** may define more than one ball receptacle **132**, and the loader arm **160** may include multiple loader arms **160**, each arm positioned between two ball receptacles **132**. When the ball cradle **110** receives a ball **12**, the loader arm **160** engages the thrower arm **108**. This increases the rate at which the thrower arm **108** can launch balls **12**.

In some implementations, not shown, the ball loader **130** is positioned on the front portion **122***b* of the support arm **122**. The motor **140** is positioned on either the front portion **122***a* or the end portion **122***c*, and the loader arm **160** is positioned on either the first portion **122***a* or the end portion **122***c*, different than the motor **140**. In such examples, the ball loader **130** is arranged such that when a ball **12** is released from the ball receptacle **132**, the ball **12** is released in the ball cradle **110** of the thrower arm **108**. In addition, the loader arm **160** is configured to engage the thrower arm **108**.

In some implementations, the motor **140** is positioned in the middle portion **122***b* of the support arm **122** and the ball loader **130** and the loader arm **160** is each positioned on either the front portion **122***a* or the end portion **122***c* of the support arm **122**. Therefore, the ball loader **130** may be positioned on the support arm **122** where the ball receptacle **132** is capable of delivering a ball **12** to the ball cradle **110** of the thrower arm **108**.

In some examples, the ball launcher **100** includes a power source **180** supported by the base **102** for powering the electrical components (e.g., the motor **140**) of the ball launcher **100**. The power source **180** may be in electrical communication with the power button, the motor **140**, and the rheostat **172** and delivers power to these components, as necessary. The power source **180** may be a battery or a direct current power supply that connects to a wall outlet.

In some examples, a cover (not shown) is disposed over the ball launcher **100**. The cover may be configured to lock with the base **102**. The cover includes several apertures for receiving a ball **12** at the ball receptacle **132** of the ball loader **130** and another aperture for releasing the ball **12** from the ball cradle **110** of the thrower arm **108**. The cover may include a handle allowing a user **10** to easily carry the ball launcher **100** from a first location to a second location. The power button **170** and the rheostat **172** are protruding out of the cover allowing a user **10** the capability to activate or deactivate the ball launcher **100** or to change the frequency of the ball release. In some examples, the ball launcher **100** is controlled by a remote control, such that a user **10** can turn the ball launcher **100** on or off, adjust the frequency of the thrower arm **108**, adjust the thrower stop **112**, and/or adjust the distance D_L of each leg **104** from the ground surface **14**. The cover may be attached to the base **102** by one or more methods including but not limited to bolting, threading, welding, or frictional engagement. These methods may also be used to secure other parts of the ball launcher **100** together. In some examples, a bolt and a nut are used secure the parts to one another or to the base **102**.

The ball launcher **100** helps a user **10** build muscle memory because the user **10** can configure the ball launcher **100** to his/her preferred settings and repeatedly hit the ball **12**. Muscle memory is a form of procedural memory that involves consolidating a specific motor task into memory through repetition of that motor task. Therefore, the ball launcher **100** launches a ball **12** repetitively at the same height, at the same speed, and at the same angle with every repetition, which over time causes a long-term muscle memory to be created for that task, eventually allowing the player **10** to perform that task without conscious effort. Therefore, the ball launcher **100** builds the muscle memory of a player **10**, allowing the player **10** to improve his/her serve.

Referring to FIG. **11**, a method **1100** for launching a ball is described with reference to FIGS. **1-10**B. The method includes setting **1102** a ball receiving or releasing position of a thrower arm **108** pivotally supported by an arm holder **106** about a first axis of rotation R_X. The thrower arm **108** may be spring biased about the first axis of rotation R_X between the ball receiving or releasing position and an engaged position. The method further includes loading **1104** a ball **12** into a ball receptacle **132** defined by a ball loader **130** coupled to a rotating shaft **150** for common rotation about a second axis of rotation R_Y defined by the rotating shaft **150** when the rotating shaft **150** rotates, the second axis of rotation R_Y substantially perpendicular to the first axis of rotation R_Y. The method also includes rotating **1106** the ball loader **130** and the rotating shaft **150** in unison about the second axis of rotation R_Y. As the ball loader rotates, the ball receptacle **132** releasing the received ball **12** from the ball receptacle **132** into a ball cradle **110** connected to the thrower arm, and a loader arm **160** moving the thrower arm **108** from the ball receiving position to the engaged position when the loader arm **160** contacts a contract surface **208** associated with the thrower arm. The loader arm **160** is releasably connected to the rotating shaft **150** for common

rotation about the second axis of rotation R_Y when the rotating shaft **150** rotates. The loader arm **160** defines a longitudinal axis X_{arm} substantially perpendicular to the second axis of rotation R_Y of the rotating shaft **150**.

Referring to FIG. **12**, in some implementations, a method **1200** of launching a ball **12** includes receiving **1202** a ball **12** in a ball receptacle **132** defined by a ball loader **130**, rotating **1204** the ball loader **130** about an axis of rotation R_Y, and releasing **1206** the received ball **12** from the ball receptacle **132** into a ball cradle **110** disposed on a pivotally supported spring biased thrower arm **108**. The method **1200** also includes rotating **1208** a loader arm **160** about the axis of rotation R_Y and engaging the loader arm **160** with the thrower arm **108**. The loader arm **160** moves the thrower arm **108** between a ball receiving or releasing position (where the ball cradle **110** is not supporting a ball **12**) and an engaged state (where the loader arm **160** is engaged with the thrower arm **108**).

Referring back to FIGS. **1-12**, the method **1100**, **1200** may further include releasing the received ball **12** from the ball receptacle **132** into the ball cradle **110** before the loader arm **160** engages the thrower arm **108**. The method **800**, **900** may also include releasing the received ball **12** from the ball receptacle **132** into the ball cradle **110** after the loader arm **160** engages the thrower arm **108** and before the loader arm **160** moves the thrower arm **108** from its ball receiving position to its engaged position.

The loader arm **160** may extend perpendicular to the axis of rotation R_Y. The loader arm **160** may define more than one ball receptacle **132**. In some examples, the method **1100**, **1200** includes adjusting a length L_{arm} of the loader arm **160** to alter an angular pivot range of the thrower arm **108** about the first axis of rotation R_X while engaged by the loader arm **160**.

The method **1100**, **1200** may also include adjusting a position of the loader arm **160** about the rotating shaft **150** along the second axis of rotation R_Y to alter an angular pivot range of the thrower arm **108** while engaged by the loader arm **160**. The method **1100**, **1200** may include limiting pivotal movement of the thrower arm **108** to set the ball releasing position of the thrower arm **108** having a ball launching point LP. Additionally or alternatively, the method **1100**, **1200** may include adjusting a thrower stop **112** arranged to limit pivotal movement of one end of the thrower arm **108**. The thrower arm **108** having a first end **108***a* connected to the ball cradle **110** and a second end **108***b* rotatably supported by the arm holder about the first axis of rotation R_X.

A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the disclosure. Accordingly, other implementations are within the scope of the following claims.

What is claimed is:

1. A ball launcher comprising:

a horizontal base;

a thrower arm mounted to an arm holder which is mounted to the horizontal base;

the thrower arm spring biased and pivotal about a transverse axis between a ball receiving or releasing position and an engaged position;

a rotating shaft mounted along an axis perpendicular to the transverse axis, wherein the rotating shaft includes a ball loader for dispensing a ball onto the thrower arm; and

a loader arm, wherein, a ball is dispensed to the thrower arm and then the loader arm contacts the thrower arm, pushing against the spring bias, then releases the thrower arm to pivot upward and launch the ball.

2. The ball launcher of claim **1**, wherein the ball loader releases the received ball from a ball receptacle into a ball cradle before the loader arm engages the thrower arm.

3. The ball launcher of claim **1**, wherein the ball loader releases the received ball from a ball receptacle into a ball cradle after the loader arm engages the thrower arm and before the loader arm moves the thrower arm from its ball receiving position to its engaged position.

4. The ball launcher of claim **1**, wherein the loader arm has a variable length.

5. The ball launcher of claim **1**, wherein the loader arm has a variable position about the rotating shaft along the axis perpendicular to the transverse axis.

6. The ball launcher of claim **1**, wherein a contact surface associated with the thrower arm comprises a top surface of the thrower arm.

7. The ball launcher of claim **1**, wherein a contact surface associated with the thrower arm is supported by an engagement member disposed on the thrower arm, the thrower arm defining a longitudinal axis substantially parallel to the fore-aft axis when the thrower arm is in the ball receiving or releasing position.

8. The ball launcher of claim **7**, wherein the contact surface comprises a roller rotatably supported by the engagement member.

9. The ball launcher of claim **7**, wherein the contact surface is angled with respect to the longitudinal axis of the thrower arm.

10. The ball launcher of claim **7**, wherein the engagement member has a variable position about the thrower arm along the longitudinal axis of the thrower arm.

11. The ball launcher of claim **7**, wherein a contact point between the loader arm and the contact surface has a variable height from the thrower arm with respect to the center vertical axis of the horizontal base based upon a position of the engagement member about the thrower arm along the longitudinal axis of the thrower arm and a position of the loader arm about the rotating shaft along the axis perpendicular to the transverse axis.

12. The ball launcher of claim **1**, further comprising:

a motor coupled to a back end of the rotating shaft for common rotation about the axis perpendicular to the transverse axis when the motor rotates.

13. The ball launcher of claim **1**, further comprising a thrower stop arranged to limit pivotal movement of the thrower arm to set the ball receiving or releasing position of the thrower arm.

14. The ball launcher of claim **1**, further comprising:

a spring support disposed on a second end of the thrower arm;

a thrower stop disposed between the spring support and the horizontal base, the thrower stop limiting pivotal movement of the thrower arm about the first axis of rotation to set the ball receiving or releasing position of the thrower arm; and

one or more springs connecting the spring support to one of the thrower stop or the horizontal base, the springs biasing the thrower arm in the ball receiving or releasing position when the loader arm and the thrower arm are disengaged and a ball cradle is unoccupied.

15. The ball launcher of claim **14**, wherein the thrower stop telescopes between a retracted position and an expanded position to set the ball receiving or releasing position of the thrower arm.

16. The ball launcher of claim 1, further comprising one or more legs supporting the horizontal base, each leg having an adjustable length to tilt the horizontal base with respect to a supporting surface.

17. A method of launching a ball comprising:

providing a thrower arm including a thrower arm spring pivotally supported by an arm holder that is mounted to a horizontal base , wherein the thrower arm spring is biased and pivotal about a transverse axis between a ball receiving or releasing position and an engaged position;

mounting a rotating shaft along an axis perpendicular to the transverse axis, wherein the rotating shaft includes a ball loader for

dispensing a ball onto the thrower arm, wherein as the rotating shaft rotates, the ball is dispensed to the thrower arm and then a loader arm contacts the thrower arm, pushing against the spring bias, then releases the thrower arm to pivot upward and launch the ball.

18. The method of claim 17, wherein a ball receptacle releases the received ball from the ball receptacle into the cradle before the loader arm engages the thrower arm.

19. The method of claim 17, wherein a ball receptacle releases the received ball from the ball receptacle into the ball cradle after the loader arm engages the thrower arm and before the loader arm moves the thrower arm from its ball receiving position to its engaged position.

20. The method of claim 17, further comprising adjusting a length of the loader arm to alter an angular pivot range of the thrower arm about the transverse axis while engaged by the loader arm.

21. The method of claim 17, further comprising adjusting a position of the loader arm about the rotating shaft along the axis perpendicular to the transverse axis to alter an angular pivot range of the thrower arm while engaged by the loader arm.

22. The method of claim 17, further comprising limiting pivotal movement of the thrower arm to set the ball receiving or releasing position of the thrower arm.

23. The method of claim 17, further comprising adjusting a thrower stop arranged to limit pivotal movement of the thrower arm, the thrower arm having a first end connected to the ball cradle and a second end rotatably supported by the arm holder about the transverse axis.

24. The method of claim 23, further comprising connecting one or more springs between a spring support disposed on the second end of the thrower arm and one of the thrower stop or the horizontal base, the springs biasing the thrower arm in the ball receiving or releasing position when the loader arm and the thrower arm are disengaged and the ball cradle is unoccupied.

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